Analysis

Consumer Response to Climate Adaptation Strategies in the Food Sector: An Australian Scenario

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ABSTRACT

The viability of climate adaptation strategies adopted by agrifood companies rely heavily on how well consumers understand, accept and/or select commodities and their willingness to bare some of the cost of adaptation. To understand this issue in more detail, a survey was undertaken of 1532 Australian consumers to investigate how they respond to adaptation strategies in terms of acceptance and willingness to pay. The survey results contained in this paper focus on three product categories – mango, potato chips and wine. The survey revealed that when faced with climate-adapted mango, potato chips or wine products, respondents were most likely to substitute or purchase less often rather than purchasing a more expensive 'adapted' product or a cheaper 'non-adapted' product. Across the three commodities, the level of acceptance also varied little with socio-demographic factors and the respondent's perceptions of climate change. The study highlights the importance of communicating the climate adaptation initiatives of agrifood companies and the challenges faced by these companies in raising the awareness associated with climate-adapted product.

1. Introduction

Adaptation has been defined as any "adjustment in natural or human systems to a new or changing environment that exploits beneficial opportunities or moderates negative effects" (Bierbaum et al. 2014: 672). Adaptation to climate change can occur at a range of scales from incremental, to systemic through to transformational (Rickards and Howden, 2012). Incremental business adaptation is generally accepted as small improvements or adjustments in enterprises at a single node in the supply chain which maintain the essence and integrity of a system (Dowd et al., 2014; Furman et al., 2014; Kates et al., 2012; Lim-Camacho et al., 2015; Park et al., 2012; Rickards and Howden, 2012) with the view to maintain 'status quo'. Incremental adaptations are generally small-scale, discrete responses to the impact of climate change. Although these incremental adaptations could be reactive, they may effectively decrease an enterprise's vulnerability to climate fluctuations in the short-term, and thus have the potential to be maladaptive. Systemic adaptation refers to the adoption of a range of incremental adaptation options that serve to shift the operating system to a new state. Systemic adaptations are more complex than incremental adaptations and lead to some system change. These changes do not necessarily transform the business and so reside somewhere between incremental and transformational adaptation.

Transformational adaptations are defined as activities that are adopted at a much larger scale or intensity, that are truly new to a particular region or resource system, and that transform geographical land use (Kates et al., 2012). They involve a major shift in the overall goals of an enterprise or supply chain (Dowd et al., 2014; Linnenluecke et al., 2011; Park et al., 2015; Rickards and Howden, 2012). The difference between incremental and transformational adaptation is therefore both a question of scale and the willingness to shift from maintaining the 'status quo', although the distinction between the two may not always be clear-cut (Kates et al., 2012). For enterprises to undertake transformational adaptation, a high degree of adaptive capacity is required (Dowd et al., 2014; Furman et al., 2014; Lereboullet et al., 2013; Marshall, 2010; Marshall et al., 2014, 2012; Park et al., 2012; Rickards and Howden, 2012). Transformational adaptation aims to ensure long-term viability of businesses or enterprises to a broader

scale and is thus considered proactive rather than reactive (Dowd et al., 2014; Rickards and Howden, 2012).

Agribusiness and the food sector are becoming increasingly vulnerable to unprecedented fluctuations in climate (Fleming et al., 2014; Kates et al., 2012; Lim-Camacho et al., 2015; Rickards and Howden, 2012). As such, the need for adaptation to occur across the spectrum from incremental to transformative has been identified as crucial if the current supply and quality of food products is to be maintained (Kates et al., 2012; Rickards and Howden, 2012). However, to date, most literature published on climate adaptation in the food sector has focused on changes at the farm gate or risk to logistics (Lim-Camacho et al., 2017a; Plagányi et al., 2014). Very little research has been undertaken on the possible changes to the quality of food products and to understand the consumers' willingness to pay (WTP) for climate-adapted products despite a recent focus on the effect of consumer climate change attitudes and WTP for sustainability attributes (Grebitus and Lusk, 2013; Nauges and Wheeler, 2017; van Loo et al., 2015).

Climate adaptation in the food sector can lead to more directly noticeable benefits such as better quality produce and other benefits such as assurance of supply over a long period of time and earlier market penetration, and could completely buffer consumers from the impacts of climate change. While consumers may directly benefit from adaptation initiatives put in place by businesses in the food sector, there may also be instances where such benefits are not felt by the consumers due to lack of awareness of such initiatives. These climate adaptation initiatives are often expensive and hence understanding of consumer readiness and their willingness in accepting a climate-adapted product at a potentially elevated price is important for any food business to decide on the viability of their climate adaptation initiatives. This paper aims to provide new insights into how consumers may respond to climate adaptation initiatives of agrifood companies, by eliciting consumer responses to a number of hypothetical "climate-adapted" food products. Specifically, we analyse the consumer preferences and their responses to hypothetical adaptation initiatives and examine variances across three product categories.

2. Behavioural Responses to Adaptation in the Agrifood Sector

Kates et al.'s (2012) position that the scope of adaptation is not only technological but also encompasses a change in behaviours. This addresses how individuals and society make decisions and allocate resources to cope with climate change. However, in the case of the agrifood industry, studies on adaptation behaviour have mainly focused on enterprises particularly organisational culture and management, strategy and information-seeking practices in response to climate change (Dowd et al., 2014; Rickards and Howden, 2012). There is limited published empirical literature on how consumers respond to such adaptation strategies. The research have mainly focused on uncovering evidence of links between social norms and peoples' behaviours, intentions and motivation to environmental choice and preference (Gatersleben et al., 2014; Dermody et al., 2018; Li et al., 2016; Lim-Camacho et al., 2017b; van der Werff et al., 2013). For example, van der Werff et al. (2013) discuss the impact of environmental self-identity which deals with the concept of people acting in an environmentally friendly way without an external incentive to do so. Environmental self-identity is generated by a moral obligation to be environmentally friendly, however group influence impacts on behaviour and motivations towards climate change, as in the case of social norms. Consistent with this argument, Nyborg et al. (2016) highlight that individual's behaviour towards a broader global challenge such as climate change is impacted by social norms and relevant policies could support change of these social norms.

More closely aligned to consumer responses to climate adaptation is the growing interest in measuring consumers' WTP for food attributes in relation to environmental values such as natural, organic or local provenance which are driven and delivered by provenance strategies across the whole food value chain (Batte et al., 2007; D'Amico et al., 2016; van der Werff et al., 2013; White and Brady, 2014). However, White and Brady (2014) argue that these environmental attributes are 'impure' or non-standard environmental attributes and the consumers WTP a premium price for such products can be masked by their motivations to purchase healthy and/or safe food products rather than paying extra for 'pure' or standard environmental attributes relating to energy or water use. This was evidenced by Li et al. (2016) that showed consumers who readily consume organic and/or locally produced beef were less supportive of environmental programs than others surveyed and were more likely to substitute products than pay a price premium for a climate-adapted product.

van der Werff et al. (2013) concluded that some consumers are inherently motivated to act in a climate-friendly manner and environmental labels could reinforce their pre-existing intrinsic motivation to contribute to climate change mitigation (Perino et al., 2014). This would suggest that labels play a crucial role in communicating environmental attributes to consumers and hence many studies focus on determining how environmental labels could influence the demand for food products (Panzone et al., 2011; Perino et al., 2014; White and Brady, 2014). Outside the growing literature on consumers' WTP for food safety provenance, organic, certifications and environmental labelling, there is little research on more subtle food product attributes that value chains are responsible for. Climate adaptation is a case in point. To address this knowledge gap, this paper examines how consumers respond to climate adaptation initiatives of agrifood companies, the establishment of hypothetical climate-adapted products.

3. Data and Methods

3.1. Survey Instrument

This paper is based on a broader research study conducted during 2013–2016 in understanding how Australian agrifood value chains are impacted by climate change and climate variability and how such chains effectively respond through adaptation and mitigation strategies. For this study, three agrifood product categories were selected to represent a fresh fruit product with a simple chain (mangoes), a processed food product with a moderately complex chain (potato chips), and a beverage product with a complex chain (wine). A questionnaire was designed based on qualitative exploratory research through four focus group discussions conducted in Brisbane, Australia, supported by literature on climate adaptation beliefs and norms (Leiserowitz et al., 2010; Leviston et al., 2013). The focus group discussions were used to gather an in-depth understanding of the product usage as well as consumers' climate change beliefs and their perceptions. Although the findings of the focus group discussions are not reported in this paper, the key themes emerging from those discussions, as well as the specific language used by consumers around the concept of adaptation, guided the questionnaire development process.

The questionnaire comprised of four broad sections: the first focused on product-specific questions that aimed to gather information on attribute preferences, usage and adaptation scenarios; the second focused respondents' general beliefs on climate change, how they live with climate change; the third focused on specified climate change and adaptation scenarios designed to highlight potential climate change impacts for each product category and two agrifood business adaptation strategies that could address the respective climate change impact and the fourth focused on their socio-demographic characteristics. The specific scenarios were developed based on in-depth consultations with value chain members identified in the broader research project and were supported by scientific evidence. All these scenarios were initially tested during the focus group discussions and the refined scenarios were populated in the survey. Questions were designed to gather how respondents would react to the situation and the amount they expect to pay for the product that resulted based on the given scenario. These

Box 1
Climate change scenarios.

MANGO

Scenario 1: Drought in a primary mango growing region has led to a change in quality of mangoes. They are now smaller and ripen quickly. The company that sells these mangoes have no choice but to sell them this way, as they do not have any other sources to purchase the same variety of mangoes.

Scenario 2: An alternative to selling smaller, quick-ripening mangoes that are affected by drought is to focus on marketing a small amount of good quality mangoes. This means that they are not able to sell enough mangoes to meet demand for the season, which means higher prices for consumers.

Scenario 3: In an entirely different scenario, mangoes in Australia have been affected by the gradual changes in temperature and rainfall in their growing regions. Flowering times in the year have changed, so the seasons have changed making most mangoes available in July. One company has decided to make big changes and shift locations so that they can continue to produce mangoes in summer. Prices of mangoes in summer go up, while mangoes become available in winter at reasonable prices.

POTATO CHIPS

Scenario 1: A potato chips manufacturing company has a problem. Flooding in an important potato growing region in Australia has meant that the potatoes they would normally be purchasing for the season have had too much water affecting the quality of the product. The potatoes have spots that you can see once it is processed into a chip. They tested the chip and it is safe to eat, and decided that they will proceed with producing chips even if they are spotty.

Scenario 2: An alternative to producing spotty chips is for the company to focus on the 'perfect chip'. This means they will not purchase from the farmers at all. They now have less potatoes to work with and as such will not have enough chips to supply the usual demand in the market. The price then of this brand potato chips goes up.

Scenario 3: The potato chip company has decided that its farmers are very important for its business and decided to continue sourcing potatoes from this region for the future seasons, even if they are at risk of flooding in the future. They decide that they need to protect the farmers from this risk in order to protect their own business as well, so they employ specialist scientists to find ways to keep on producing high quality potatoes. This costs them more money, but they feel that it is worth it.

WINE

Scenario 1: The Adelaide Hills has had an unusual run of warm years, leading to Sauvignon Blanc wine produced in the region to be less crisp than it used to be and also have a brownish tinge. Your favourite brand has been affected in particular.

Scenario 2: In an alternate scenario, the wine producer has decided that it is unacceptable to have a brownish tinge and a reduction to the crispness to their Sauvignon Blanc. Ongoing drought conditions have led them to purchase vineyards in Tasmania in order to produce Sauvignon Blanc in the quality standards that they desire. This is an expensive decision for them, so it affects the price that consumers have to pay per bottle.

Scenario 3: The Margaret River region in Western Australia has been affected by fires which has damaged vineyards affecting a very large, award-winning winery that you particularly like. They have decided to source all their grapes from a vineyard in Stanthorpe, in Queensland's Granite Belt, as they found that these grapes matched the quality of those produced in the Margaret River.

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scenarios represented a reduction in product quality, maintenance of high-quality standards and a transformational adaptation scenario (Box 1).

Respondents' attribute preferences, general beliefs on climate change, how they live with climate change were measured using 1–5 Likert scales. Randomised statements were used to capture how respondents react to specific scenarios and their price expectations were captured by using dollar values. Upon obtaining human research ethics approval from the Commonwealth Scientific and Industrial Research Organisation, Australia (Reference Number 080/13), a pilot test was conducted prior to the full launch to ensure that respondents are able to understand the questions and complete the survey.

3.2. Sample Selection and Data Description

A nation-wide online survey was conducted in Australia targeting primary purchasers of the three food products – fresh mangoes, potato chips (crisps), and wine. The survey was administered in 2014 by Colmar Brunton, a market research company, with sample sourced from a research-only panel. The total sample size was 1532, with specific responses from purchasers of mangoes (503), potato chips (522) and wine (507). The sample was selected to represent the general geographical spread of the Australian population (Table 1).

3.3. Data Analysis

In this study, it was hypothesised that consumers' responses to climate adaptation strategies in the food sector are influenced by three

Table 1
Sample characteristics (n = 1532).

	% Survey respondents	% Australian population 2014
State/Territory[a]		
New South Wales	31.5	32.0
Victoria	26.0	24.9
Queensland	19.6	20.1
Western Australia	9.5	11.0
South Australia	9.2	7.2
Tasmania	2.8	2.2
Australian Capital Territory	1.3	1.6
Northern Territory	0.1	1.0
Area[b]		
Capital cities	62.3	66.5
Rest of Australia	37.7	33.5

[a] Australian population as of March 2015. Source: Australian Bureau of Statistics (2015) Australian Demographic Statistics, Mar 2015. http://www.abs.gov.au/ausstats/abs@.nsf/mf/3101.0. Accessed 11 December 2015.

[b] Australian population as of June 2014. Source: Australian Bureau of Statistics (2014) Regional Population Growth, Australia, 2013–2014. http://www.abs.gov.au/ausstats/abs@.nsf/mf/3218.0/. Accessed 11 December 2015.

broad constructs, namely an individual's socio-demographic profile, their perceptions on climate change, product usage and value attribute preferences. Age, gender, household income, the level of education and location were selected to represent an individual's socio-demographic characteristics.

Perceptions on climate change were measured by using three constructs, namely perceptions of risks associated with climate change (3 items with a Cronbach's alpha value of 0.854), perceptions of climate adaptation (10 items with a Cronbach's alpha value of 0.877) and perceived support for climate change adaptation initiatives by food businesses (4 items with a Cronbach's alpha value of 0.810).

Product purchase frequency and specific value attribute preferences (12 items each to measure extrinsic and intrinsic product attributes of mango, potato chips and wine, with Cronbach's alpha values of 0.830, 0.780 and 0.855 respectively) were also considered as a construct. Summated scores were calculated for each of the constructs.

Respondents' WTP a price premium was calculated for each scenario and classified as three options – not willing to pay a price premium, indifferent and willing to pay a price premium. By adopting the ± 2 standard deviation criteria, all outlying WTP prices were removed.

Consumers' response to different climate adaptation scenarios were investigated using descriptive and ordered logistic regression analysis techniques. An ordered logistic regression model was applied given the inherent nature of the response variable (y) where the y was considered to be the three willingness to pay options following a similar study by Schwirplies (2018) to understand citizens' acceptance of climate adaptation and mitigation strategies across three European countries.

The model used for our study considers y to be conditional for explanatory variables x derived from a latent variable model depicted below (Wooldridge, 2010). The variable specifications of the model are given in Table A.1.

$$y^* = x\beta + e, \quad e|x \sim \text{Normal}(0, 1)$$

where, β is $k \times 1$ and x does not contain a constant. In the model, α_1 and α_2 are unknown cut points and was defined as

$y = 1$ if $y^* \leq \alpha_1$
$y = 2$ if $\alpha_1 < y^* \leq \alpha_2$
$y = 3$ if $y^* > \alpha_2$.

The assumption of standard normal distribution of the error term e enables a direct estimation of the conditional distribution of y given x. Each response probability was computed as a below.

$$P(y = 1 \mid x) = P(y^* \leq \alpha_1 \mid x) = P(x\beta + e \leq \alpha_1 \mid x) = \Lambda(\alpha_1 - x\beta)$$
$$P(y = 2 \mid x) = P(\alpha_1 < y^* \leq \alpha_2 \mid x) = \Lambda(\alpha_2 - x\beta)$$
$$P(y = 3 \mid x) = P(y^* > \alpha_2 \mid x) = 1 - \Lambda(\alpha_2 - x\beta).$$

The y^* is an abstract construct and hence $E(y^* \mid x) = x\beta$ does not provide any meaningful interpretation. Thus, response probabilities which can represented as $P(y = j \mid x)$ where $j = 1, 2$ and 3 were computed;

$$\partial p_1(x)/\partial x_k = -\beta_k \Lambda(\alpha_1 - x\beta),$$

$$\partial p_2(x)/\partial x_k = \beta_k [\Lambda(\alpha_2 - x\beta) - \Lambda(\alpha_2 - x\beta)], \text{ and}$$

$$\partial p_3(x)/\partial x_k = \beta_k \Lambda(\alpha_3 - x\beta).$$

4. Results and Discussion

Table 2 highlights the descriptive statistics of the total sample by product type. The samples associated with each of the three commodities reflected the general distribution of the Australian population in terms of gender and urban and rural distribution. Potato chips consumers were relatively younger, less educated and falling within the lower income profile than mango and wine consumers.

Respondents were asked to indicate the most likely action they would undertake as consumers if agrifood companies were faced with a climate change that results in producing a lower quality product (scenario 1). This was followed by another scenario in which that agrifood company responds to the climate change impact and aim to maintain a better quality product in the market (scenario 2). Similar to the first

Table 2
Socio-demographic profile of the sample.

| Variables	Mango (n = 503)	Potato (n = 522)	Wine (n = 507)
Gender (n)	503	522	507
Male (%)	50.7	45.4	53.3
Female (%)	49.3	54.6	46.7
Age (n)	420	451	400
< 30 years (%)	38.6	40.4	32.5
30–49 years (%)	23.8	28.4	18.8
50–64 years (%)	19.5	16.2	28.3
> 65 years (%)	18.1	15.1	20.5
Education attainment (n)	503	522	507
Partial/completed high school (%)	24.1	30.5	22.5
Partial/completed trade or TAFE[a] qualification (%)	26.4	31.0	26.8
Partial/completed undergraduate qualification (%)	33.0	28.0	32.0
Partial/completed postgraduate qualification (%)	16.5	10.5	18.7
Annual household income (n)	416	444	431
< $59,000 (%)	36.5	51.6	39.0
$60,000–$120,000 (%)	40.9	32.5	37.4
> $120,000 (%)	22.6	15.9	23.7
Location (n)	499	517	503
Urban (%)	68.1	51.6	68.2
Rural and regional (%)	31.9	48.4	31.8

[a] TAFE - Technical and Further Education.

scenario, respondents were then asked to indicate the most likely action they would undertake if the product quality is better due to the response by the agrifood company. In general, when faced with a climate-adapted product, consumers are most likely to substitute or purchase less often rather than purchase what is perceived to be an inferior product at the same price or a more expensive but 'adapted' product. It would appear that concern about climate change, in itself, is not enough to encourage consumers to accept a more expensive, adapted product or an inferior product. This is particularly the case with a fast moving consumer product such as potato chips where substitution is relatively easy. Based on the survey results (Table 3), consumers are less likely to substitute mangoes with other fruit, compared to wine and potato chips, particularly when the product's quality is reduced. This is not surprising, given that substitution for mangoes entails purchasing different kinds of fruit and would result in a different eating experience. There are also a wide range of wine and potato chip products available which consumers can choose from.

Efforts to maintain apparent quality standards were evident form the response related to wine more so than mangoes and potato chips. This is likely to be explained by the reputation of the wine company specified in the scenario ('award-winning') rather than the relevant importance of provenance for this product (i.e. Margaret River – a well-known Western Australian wine region). In general, wine consumers tend to be highly involved in their wine choice and their purchase is heavily influenced by brand loyalty which would suggest that they require high product standards to be maintained (Bruwer et al., 2002; Schäufele and Hamm, 2017). Amongst the scenarios presented, wine was the only case where a company is unlikely to be disadvantaged by an outcome of an adaptation strategy. Results show that similar to other competitive strategies, pricing, quality and brand equity as functions of product positioning are important considerations when developing adaptation strategies, especially when the adaptation strategy produces tangible differences for the consumer. Similarly, Zilberman et al. (2012) also highlighted that marketing efforts including information sharing, brands, and product demonstrations would minimise the uncertainties about product reliability.

In addition to the scenarios presented above, respondents were also asked to state their agreement towards a series of attitudinal statements given more significant, or systemic adaptation strategies (scenario 3).

Table 3
Adaptation scenarios.

	Reduction in product quality scenario	Maintain high quality scenario
Mangoes	Reduce quality standards to market resulting in smaller, quick-ripening mangoes	Maintain high quality standards resulting in smaller volumes and more expensive mangoes
	1. Purchase less often = 28%	1. Purchase less often = 19%
	2. Continue purchasing = 25%	2. Continue purchasing = 8%
	3. Specific use = 22%	3. Specific use = 29%
	4. Substitute = 19%	4. Substitute = 14%
	5. Not purchase = 7%	5. Not purchase = 10%
Potato Chips	Reduce raw material quality standards resulting in 'spotty chips'	Alternative supply arrangements to meet high quality standards
	1. Purchase less often = 9%	1. Purchase less often = 19%
	2. Continue purchasing = 22%	2. Continue purchasing = 8%
	3. Specific use = 12%	3. Specific use = 29%
	4. Substitute = 27%	4. Substitute = 14%
	5. Not purchase = 7%	5. Not purchase = 10%
Wine	Absorb change in wine grape quality resulting in less crisp flavour and discolouration of wine	Shift sourcing to alternate, lesser-known region with grapes that meet quality requirements
	1. Continue purchasing = 18%	1. Continue purchasing = 56%
	2. Specific use = 11%	2. Specific use = 14%
	3. Substitute = 54%	3. Substitute =21%
	4. Not purchase = 17%	4. Not purchase = 9%
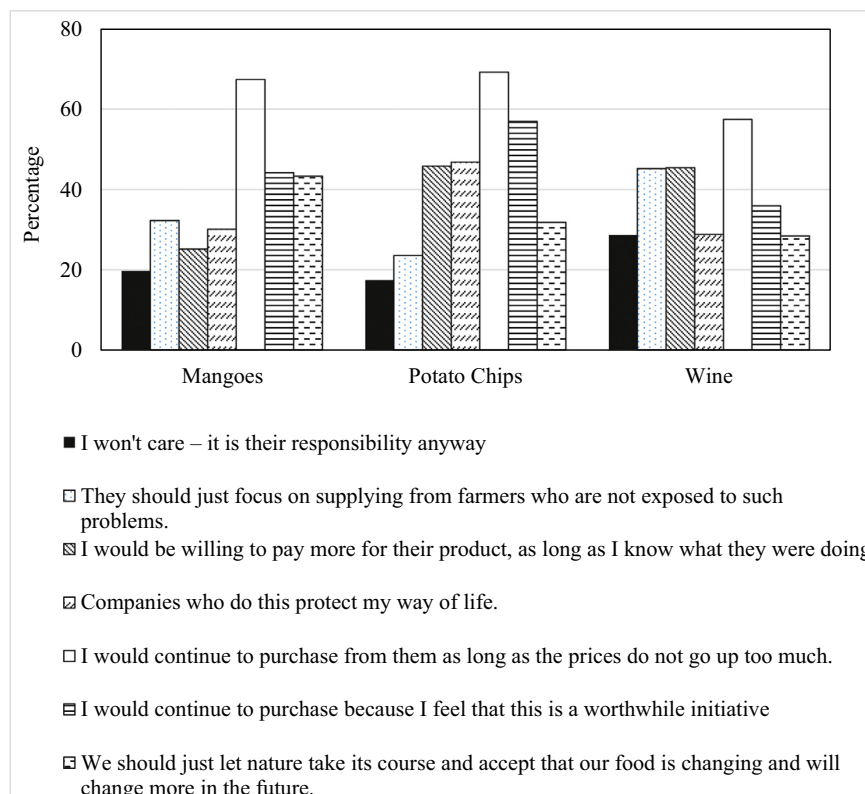
Fig. 1. Percentage of strongly agreed responses to transformational adaptation strategies.

For potato chips, this involved significant research and development investment to protect the chain's current growers from the impacts of climate change. For mangoes and wine, the transformational adaptation strategies included significant geographical shifts in production areas to avoid climate change impacts. The results for 'agree' and 'strongly agree' responses are illustrated in Fig. 1. Findings suggest that in general, respondents are happy to support these initiatives as long as the prices do not rise too much. In terms of mangoes and wine, 24% and 14% of the respondents respectively strongly supported adaptation strategies in the form of shifting production locations so that the company can continue to provide the same product offering to consumers but on the assumption that prices do not rise too much.

In terms of potato chips, 18% of the respondents strongly supported employing specialist scientists to keep on producing high-quality potatoes. It is interesting to note that, potato chips and wine showed the strongest indication that consumers would place more value on being informed of adaptation strategies, to the extent that they would pay more for a climate-adapted product. As pointed out by other studies, this could be due to the result of a moral obligation to pay more where respondents' environmental self-identity is impacting their climate change beliefs and consequently their behaviour (Gatersleben et al., 2014; O'Garra and Mourato, 2016; van der Werff et al., 2013). In essence, they feel guilty over climate change and believe they have a moral obligation to pay more if they are aware of respective adaption strategies.
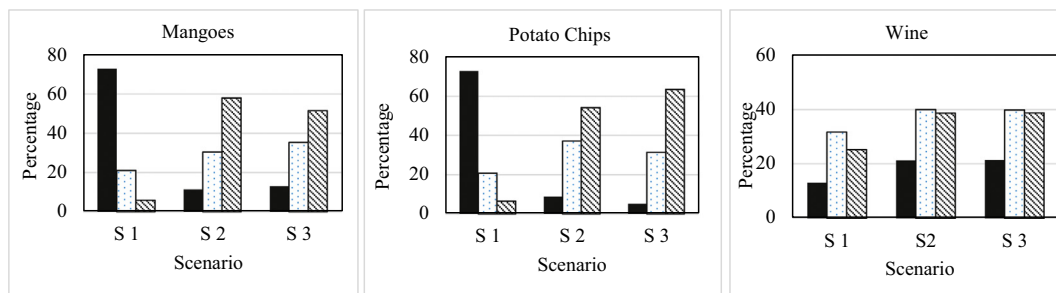
Fig. 2. Percentage of agreement for each of the scenario.
Note: S1, S2 and S3 represent scenarios 1, 2 and 3 with each of the bars representing ■ Not willing to pay a price premium; ▫ Indifferent; ▨ Willing to pay a price premium.

The behavioural component of adaptation was further analysed based on the respondents' WTP a premium price for each of the three scenarios discussed above. Respondents' behaviour towards price is depicted in Fig. 2 and it clearly shows that in terms of mangoes and potato chips respondents are not WTP a price premium for a product that they perceive to be an inferior product. Consistent with the previous discussion, it was noted that respondents are happy to support the adaptation initiatives of mangoes and potato chips by paying a price premium than that of wine. This could be due to the fact that wine consumers' perception of who should bear the responsibility of any adaptation strategy in the wine industry or the influence of a moral obligation to pay more driven by respondents' environmental self-identity (van der Werff et al., 2013).

Results from the WTP analysis revealed that there are considerable differences across the three product categories. In terms of wine, variation across the scenarios was not statistically significant ($P = 0.05$). This highlights that the three broad constructs specified in the models i.e. individual's socio-demographic characteristics, their perceptions on climate change, product usage and value attribute preferences – do not explain the respondents' behaviour towards wine even if the wine attributes are impacted by climate change or preserved by adaptation strategies. As discussed, this could be due respondents' general perception that any cost of the adaptation strategy should be borne by the agrifood company rather than individuals and the relatively easy product substitution. These findings align with the research by Li et al. (2016) and O'Garra and Mourato (2016) where they highlighted that consumers are less supportive of climate adaptation strategies and the cost of any adaptation strategy should be borne by someone else. In terms of wine, any significant shift in production area would not allow the agrifood company to claim the provenance for a renowned wine such as Margaret River and hence this could influence the behavioural response of the individuals. These could explain the low variability in WTP premium for three of the wine scenarios and hence lead to non-significant models.

Results from the WTP analysis revealed that only two scenarios of mango and all three scenarios of potato chips were significant ($P = 0.05$). The analysis revealed that gender, age, education, income, location, mango value attributes, climate change risk and adaptation perceptions play a significant role in influencing the purchasing behaviour with regard to mangoes, with fewer influencing potato chip purchasing behaviour (i.e. education, location, purchase frequency and climate change support) (Tables 4 and 5). These results a well aligned with the finding of Schwirplies (2018) where age, gender, income and education were found to have a significant influence on the level of climate change adaptation acceptance. Tables A.2 and A.3 report the estimated marginal effects by WTP category for mangoes and potato chips under different scenarios. These marginal effects (dy/dx) for covariates show the change in probability of WTP when an explanatory variable increase by one unit, while for factor levels this shows the discrete change of the explanatory variable from its base level.

Table 4
Ordered logistic regression results for respondents' intentions of paying a premium price under different scenarios of mango.

Variables	Model parameters			
	Scenario 2		Scenario 3	
	Number of obs = 332		Number of obs = 333	
	LR Chi²(17) = 32.54		LR Chi²(17) = 54.33	
	Prob > Chi² = 0.0129		Prob > Chi² = 0.000	
	Pseudo R² = 0.0534		Pseudo R² = 0.0842	
	Log likelihood = −288.679		Log likelihood = −295.516	
	Coeff.	*P > z*	Coeff.	*P > z*
2.gender	0.691	0.007	0.982	0.000
age				
2	−0.123	0.689	−0.284	0.337
3	0.169	0.620	0.472	0.163
4	0.302	0.410	0.828	0.025
education				
2	−0.036	0.913	−0.077	0.815
3	−0.026	0.935	−0.146	0.645
4	0.987	0.018	0.531	0.182
income				
2	−0.041	0.880	0.503	0.061
3	−0.382	0.232	0.241	0.435
2.location	0.487	0.072	0.170	0.515
pfrequency_m				
2	0.079	0.786	−0.154	0.583
3	−0.123	0.756	0.328	0.404
4	−0.185	0.607	0.041	0.910
attributes_m	−0.054	0.004	−0.081	0.000
cc_perceptions	0.129	0.049	0.051	0.411
cc_adaptation	−0.033	0.196	−0.042	0.092
cc_support	−0.016	0.736	0.049	0.282
/cut1	−4.284		−5.147	
/cut2	−2.437		−2.971	

Note: Test of parallel lines results for Scenario 2 - χ^2 (17) = 11.799 *P*-value = 0.812 and Scenario 3 - χ^2 (17) = 18.462 *P*-value = 0.360.

In terms of mangoes, the model that considered the respondent's WTP a price premium for the climate change scenario 1 was not significant. Models based on the other two mango scenarios were significant and indicated that probability of female respondents paying a price premium for mangoes in scenarios 2 and 3 were 15% and 21% more likely than males. However, it was noted that product value attribute preference has a negative impact on both these scenarios. The probability of paying a price premium for mangoes in these two scenarios tends to decrease by 1% and 2% with respondents preference change. For the mango scenario 2 the probability of paying a price premium increases when respondent's education change from high school to postgraduate education (0.20) and location changes from

Table 5
Ordered logistic regression results for respondents' intentions of paying a premium price under different scenarios of potato chips.

Variables	Model parameters					
	Scenario 1		Scenario 2		Scenario 3	
	Number of obs = 366		Number of obs = 361		Number of obs = 361	
	LR Chi^2(17) = 30.16		LR Chi^2(17) = 33.77		LR Chi^2(17) = 38.43	
	Prob > Chi^2 = 0.0252		Prob > Chi^2 = 0.009		Prob > Chi^2 = 0.0021	
	Pseudo R^2 = 0.0567		Pseudo R^2 = 0.0498		Pseudo R^2 = 0.0654	
	Log likelihood = −50.788		Log likelihood = −22.115		Log likelihood = −274.67	
	Coeff.	P > z	Coeff.	P > z	Coeff.	P > z
2.gender	−0.349	0.170	0.098	0.660	−0.084	0.723
age						
2	0.048	0.878	−0.265	0.328	0.066	0.820
3	0.019	0.957	−0.097	0.766	0.047	0.892
4	−0.082	0.843	−0.221	0.538	0.113	0.766
education						
2	−0.343	0.305	0.668	0.017	0.610	0.040
3	0.317	0.339	−0.108	0.711	0.131	0.672
4	0.418	0.326	0.182	0.647	0.640	0.146
income						
2	0.442	0.111	0.291	0.243	0.177	0.508
3	−0.204	0.599	0.394	0.221	0.279	0.421
2.location	0.506	0.047	0.108	0.624	0.283	0.232
pfrequency_p						
2	−0.487	0.220	−0.189	0.625	0.069	0.864
3	−0.883	0.029	0.054	0.887	0.555	0.167
4	−0.808	0.043	−0.199	0.594	−0.085	0.829
attributes_p	0.045	0.022	−0.017	0.303	−0.011	0.522
cc_perceptions	0.018	0.757	−0.020	0.700	−0.075	0.191
cc_adaptation	−0.004	0.890	−0.002	0.914	0.032	0.203
cc_support	0.001	0.976	0.182	0.000	0.176	0.000
/cut1	2.548		−0.327		0.019	
/cut2	4.542		1.964		2.643	

Note: Test of parallel lines results for Scenario 1 - χ^2 (17) = 15.202 P-value = 0.581; Scenario 2 - χ^2 (17) = 19.235 P-value = 0.315 and Scenario 3 - χ^2 (17) = 19.985 P-value = 0.275.

urban to rural or regional (0.16). Similarly, the probability of paying a price premium tends to increase by 3% when there was a change in respondents' climate change risk perceptions. For the mango scenario 3 that represented a transformational adaptation strategy, responses varied by only 2% when respondent's age was considered and 6% when responses were partitioned across household income categories. The probability of paying a price premium for a transformational strategy in mango increased by 8% when there is a change in respondents' climate adaptation perceptions.

All three models based on potato chips were significant ($P = 0.05$). The model that considered the respondent's WTP a price premium for a climate change scenario, resulting in spotty potato chips (scenario 1) showed the probability of paying a price premium increased when a respondent's location changed from urban to rural or regional (0.07). The probability of paying a price premium also tends to increase by 4% when there is a change in respondents' attribute preferences. However, the probability of paying a price premium tends to increase with decline in purchase frequency. Trade or TAFE qualified respondents were WTP a price premium for potato chips with high-quality standards (scenario 2) and they were also willing to contribute to significant research and development investment to protect the current growers from the impacts of climate change (scenario 3). The probability of paying a price premium increased by 2% for scenario 2% and 4% for scenario 3 when respondent's level of education changed from high school to trade or TAFE qualifications. Although, the respondent's perceptions on their support for climate change had a significant and a positive impact on how they respond to the climate-adapted product, the probability of paying a price premium tended to be minimal for both scenarios.

5. Conclusions

Agrifood supply chains, from input supply to consumption, are impacted by climate change. It is recognised that the sector needs to respond to such change by first identifying the nature of the risk to the chain and then adopting a combination of incremental to transformational adaptation strategies to mitigate the risk or maximise the opportunity. Implementation of any such adaptation strategy is resource-intensive and hence it is vital for agrifood businesses to understand whether consumers are happy to bear the cost by paying extra for such action. The results of this study would suggest that WTP is not consistent across product categories, and products with stronger provenance characteristics are more likely to benefit from higher WTP thresholds than those with less prominent provenance characteristics. The varying WTP across the three products and multiple scenarios would suggest that consumer value for adapted food products is multidimensional and hence investment in understanding product related consumer behaviour is crucial for the development of appropriate marketing strategies. This is particularly true for agrifood companies planning on developing climate adaptation strategies for the future. Thus, the challenge faced by agrifood companies is how to demonstrate return on investment for adaptation, when adaptation is implemented to avoid a climate change outcome i.e. maintain the status quo as opposed to changing the nature of the food product. In this regard, agrifood companies could align their climate adaptation strategies with corporate social responsibility, pro-environmental behaviour activities, that help build and sustain brand equity. The strength of consumer relationships to products and brands will be crucial in gaining market-

based benefits from adaptation.

The study highlighted that concern about climate change, in itself, is not great enough to encourage consumers to accept a more expensive, adapted product or an inferior, non-adapted product. This is particularly the case for fast moving consumer product such as potato chips where substitution is relatively easy. For wine, a greater emphasis was placed on preserving the value attributes of wine and maintaining the quality of the product. Mangoes were an exceptional case where off-season availability was identified as a beneficial trait even though this would be counter to the current "seasonal" attribute focus of existing advertising. As pointed out by Nyborg et al. (2016) there is a clear indication that the tipping point where vicious cycle turns into a virtuous cycle is yet to come in Australia in the case of these three product categories and hence change in social norms through relevant policy or information provision could support individual behavioural and attitudinal changes.

Socio-demographic factors such as gender, age, education and location, and respondents' perceptions of climate change had a significant influence on whether the respondents were happy to bear an additional cost or not. Given the increasing impact of climate change across the food system, the importance of educating consumers about climate change and potential impacts on the food industry is clear. The study does support the value of educating consumers about climate change and adaptation strategies that agrifood companies may implement, through positive shifts in WTP demonstrated after change in respondents' climate change risk perceptions were simulated. Although information could act as a catalyst in changing behaviour, identity and social norms, to gain better outcomes the climate change communications of these agrifood companies should be aimed at different consumer groups based on their values, identities, and personal priorities. While differences in WTP based on product type, socio-demographic factors and perceptions are 'standard' market segmentation challenges that businesses often manage when releasing new products, re-branding, or entering new markets, this study shows that climate change and climate adaptation brings forth a new perspective of consumers that businesses can use to better align internal risk management strategies with marketing strategies.

Compliance With Ethical Standards

Ethics approval was obtained from the CSIRO Social Science Human Research Ethics Committee (Reference number 080/13). Respondents provided informed consent prior to participating in the survey.

Conflict of Interest

The authors declare that they have no conflict of interest.

Appendix A

Table 1
Variable specifications.

Variable	Variable name	Variable specifications
WTP	Intensions of paying a premium price for products under each scenario	1 = not willing to pay a price premium, 2 = indifferent and 3 = willing to pay a price premium
Socio-economic characteristics		
gender	Gender	1 = male and 2 = female
age	Age	1 ≤ 30 years, 2 = 30–49 years, 3 = 50–64 years and 4 ≥ 65 years
education	Level of education	1 = partial/completed high school, 2 = partial/completed trade or TAFE qualification, 3 = partial/completed undergraduate qualification and 4 = partial/completed postgraduate qualification
income	Annual household income	1 ≤ $59,000, 2 = $60,000–$120,000 and 3 ≥ $120,000
location	Location of stay	1 = urban and 2 = rural and regional
Specific product related variables		
pfrequency_m or p	Product purchase frequency	1 = several times a week, 2 = once a week, 3 = once in two weeks and 4 = once a month or less frequent
attributes_m or p	Product value attribute preference	A composite score calculated based on 12 items of intrinsic and extrinsic value attributes (α_{Mango} = 0.830, α_{Potato} = 0.830 and α_{Wine} = 0.855)
Perceptions on climate change		
cc_risk perceptions	Climate change risk perceptions	A composite score calculated based on 3 items that measure Climate change risk perceptions (α = 0.854)
cc_adaptation	Climate adaptation perceptions	A composite score calculated based on 10 items that measure perceptions of climate adaptation (α = 0.877)
cc_support	Perceived support for climate change initiatives	A composite score calculated based on 4 items that measure perceived support for climate change adaptation initiatives (α = 0.877)

Table 2
Estimated average marginal effects by WTP category – mango.

| | Scenario 2 | | | | | | Scenario 3 | | | | | |
| | WTP = 1 | | WTP = 2 | | WTP = 3 | | WTP = 1 | | WTP = 2 | | WTP = 3 | |
	dy/dx	P > z	dy/dx	P > z	dy/dx	P > z	dy/dx	P > z	dy/dx	P > z	dy/dx	P > z
2.gender	−0.063	0.008	−0.090	0.007	0.154	0.005	−0.095	0.000	−0.118	0.000	0.213	0.000
age												
2	0.013	0.690	0.015	0.690	−0.028	0.689	0.034	0.342	0.027	0.343	−0.062	0.338
3	−0.016	0.617	−0.022	0.618	0.037	0.617	−0.045	0.158	−0.058	0.165	0.103	0.156
4	−0.027	0.403	−0.039	0.407	0.066	0.403	−0.069	0.022	−0.108	0.024	0.177	0.018
education												
2	0.004	0.912	0.004	0.913	−0.008	0.913	0.008	0.815	0.009	0.816	−0.017	0.815
3	0.003	0.935	0.003	0.935	−0.006	0.935	0.015	0.641	0.017	0.648	−0.032	0.644
4	−0.072	0.024	−0.130	0.013	0.202	0.012	−0.044	0.182	−0.069	0.179	0.113	0.175
income												
2	0.004	0.880	0.005	0.880	−0.009	0.880	−0.050	0.070	−0.060	0.060	0.110	0.059
3	0.038	0.245	0.047	0.226	−0.085	0.229	−0.026	0.432	−0.027	0.442	0.053	0.435
2.location	−0.042	0.056	−0.064	0.079	0.106	0.065	−0.016	0.504	−0.021	0.522	0.037	0.514
pfrequency_p												
2	−0.007	0.783	−0.010	0.787	0.017	0.785	0.016	0.592	0.018	0.575	−0.034	0.583
3	0.012	0.763	0.015	0.753	−0.027	0.757	−0.029	0.367	−0.042	0.420	0.071	0.398
4	0.018	0.623	0.023	0.599	−0.041	0.609	−0.004	0.910	−0.005	0.911	0.009	0.910
attributes_p	0.005	0.006	0.003	0.003	−0.012	0.002	0.008	0.000	0.010	0.000	−0.018	0.000
cc_perceptions	−0.012	0.055	−0.016	0.046	0.029	0.045	−0.005	0.413	−0.006	0.410	0.011	0.410
cc_adaptation	0.003	0.200	0.004	0.193	−0.007	0.192	0.004	0.096	0.005	0.090	−0.009	0.088
cc_support	0.001	0.736	0.002	0.736	−0.003	0.736	−0.005	0.283	−0.006	0.282	0.011	0.280

Note: dy/dx for factor levels is the discrete change from the base level.
dy/dx based on Delta-method.

Table 3
Estimated average marginal effects by WTP category – potato chips.

Scenario 1							Scenario2							Scenario 3					
	WTP = 1		WTP = 2		WTP = 3			WTP = 1		WTP = 2		WTP = 3			WTP = 1		WTP = 2		WTP = 3	
	dy/dx	P > z	dy/dx	P > z	dy/dx	P > z		dy/dx	P > z	dy/dx	P > z	dy/dx	P > z		dy/dx	P > z	dy/dx	P > z	dy/dx	P > z
2.gender	0.065	1.37	−0.047	0.172	−0.018	0.185		−0.008	0.661	−0.014	0.661	0.022	0.660		−0.008	0.661	0.014	0.723	−0.018	0.723
age																				
2	−0.009	0.878	0.006	0.878	0.002	0.878		0.023	0.333	0.038	0.327	−0.061	0.327		0.023	0.333	−0.011	0.819	0.014	0.819
3	−0.004	0.957	0.003	0.957	0.001	0.957		0.008	0.769	0.014	0.765	−0.022	0.766		0.008	0.769	−0.008	0.892	0.010	0.892
4	0.015	0.842	−0.011	0.842	−0.004	0.840		0.019	0.553	0.032	0.529	−0.051	0.537		0.019	0.553	−0.019	0.766	0.024	0.765
education																				
2	0.058	0.304	−0.044	0.305	−0.014	0.316		−0.051	0.024	−0.102	0.016	0.153	0.015		−0.051	0.024	−0.103	0.039	0.130	0.038
3	−0.062	0.337	0.046	0.339	0.017	0.345		0.011	0.711	0.0141	0.710	−0.025	0.710		0.011	0.711	−0.022	0.671	0.029	0.671
4	−0.083	0.339	0.059	0.332	0.024	0.367		−0.012	0.638	−0.026	0.654	0.042	0.647		−0.017	0.638	−0.108	0.138	0.136	0.129
income																				
2	−0.085	0.112	0.061	0.115	0.024	0.127		−0.026	0.243	−0.041	0.244	0.067	0.240		−0.026	0.243	−0.029	0.507	0.038	0.506
3	0.034	0.591	−0.026	0.592	−0.008	0.588		−0.033	0.198	−0.057	0.232	0.090	0.215		−0.033	0.198	−0.046	0.418	0.059	0.413
2.location	−0.093	0.044	0.067	0.044	0.026	0.066		−0.009	0.624	−0.016	0.624	0.025	0.624		−0.009	0.624	−0.047	0.230	0.060	0.228
pfrequency_p																				
2	0.104	0.227	−0.07	0.217	−0.034	0.265		0.016	0.616	0.027	0.630	−0.043	0.624		0.016	0.616	−0.012	0.864	0.015	0.864
3	0.177	0.036	−0.124	0.031	−0.052	0.075		−0.004	0.888	−0.008	0.887	0.012	0.887		−0.004	0.888	−0.093	0.169	0.115	0.178
4	0.164	0.052	−0.115	0.045	−0.049	0.094		0.017	0.582	0.029	0.601	−0.046	0.593		0.017	0.582	0.014	0.829	−0.019	0.828
attributes_p	−0.008	0.019	0.006	0.019	0.002	0.036		0.001	0.305	0.002	0.304	−0.004	0.301		0.001	0.305	0.002	0.522	−0.002	0.521
cc_perceptions	−0.003	0.757	0.002	0.757	0.001	0.757		0.002	0.700	0.003	0.699	−0.005	0.700		0.002	0.700	0.012	0.187	−0.016	0.187
cc_adaptation	0.001	0.890	−0.001	0.890	0.000	0.890		0.000	0.914	0.000	0.914	−0.001	0.914		0.000	0.914	−0.005	0.200	0.007	0.200
cc_support	0.000	0.976	0.000	0.976	0.000	0.976		−0.017	0.000	−0.026	0.000	0.042	0.000		−0.016	0.000	−0.029	0.000	0.037	0.000

Note: dy/dx for factor levels is the discrete change from the base level.
dy/dx based on Delta-method.

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